# Miacomet Pond
# Annual Report
# 2005

Prepared for:
Marine and Coastal Resources Department
34 Washington St.
Nantucket, MA. 02554

Prepared by:
Keith L. Conant
Town Biologist

February 2006

Introduction:

Miacomet Pond is located on the southwest portion of Nantucket Island. The pond has a surface area of 47.29 acres and a watershed area of 970.61 acres. The watershed and four sub-watersheds were derived by Horsley Witten Hegemann, Inc. in 1990. The pond is long and narrow extending an approximate mile in length. The upper third portion is a relative bottle neck, only several yards wide, extending to Otakomi Rd. Heavy development has occurred in the watershed over time, changing the characteristics of the pond's hydrology and water quality. Miacomet can no longer be considered a fresh water pond. Because it has been open to the ocean so many times in the last few years, salinity changes have affected plant and animal communities.

Miacomet Pond is monitored by the Marine & Coastal Resources Department for water quality. Temperature, dissolved oxygen, salinity, clarity and overall depth are now measured at three sites. Nutrient information was collected and analyzed 6 times this year, and one sample was taken from the head of the pond in August. The Woods Hole Oceanographic Institute in a report on Nantucket Ponds (1993), found the pond to be stressed on occasion, with moderate to poor water quality. The Department of Environmental Protection has also monitored this pond, and in 1995, found that Miacomet does not meet state standards for fish consumption due to mercury levels above (.5ppm Hg). Aquatic Control Technology found the pond to be nutrient stressed in their assessment from 1997. Applied Science Associates also completed a nutrient loading model in 2002. In ASA's report, Ivan Valiela calculated the nutrient loads in each of the four sub-watersheds; indicating the golf course, septic systems, and fertilizers as the main contributors to eutrophication in the pond. The Nantucket Health Department also collects water samples here, and has shone that during certain summers the waters have been unsafe for swimming due to fecal coliform counts above (200 fcu/100ml).

Development has altered two natural processes, (1) nitrogen/phosphorus cycles and (2) flooding. The change in land use has increased nitrogen and phosphorus concentration in the groundwater and inhibited or redirected the direction of groundwater flow. Housing densities have inhibited the percolation of precipitation, and have occupied large volumes of land previously open to groundwater filtration. Sedimentation and erosion has also increased as a result of the construction of roofs, lawns, and driveways. Roads have also increased surface runoff volume, and the direction of that runoff has increased flow to the pond.

Increased nutrients have led to increases in vegetation (phragmities & pond weeds). As a result, eutrophication has increased and deeper bottom areas are filled with decaying plant material. The shallowness of the pond prohibits a large storage of water. Large increases in precipitation combined with an already high groundwater level will flood the watershed rapidly. Nutrients carried by sediments and water flow advance the growth of nuisance vegetation in and around the pond. The pond will continue to shrink in over all volume while increasing the incidence of flooding over time.

The Miacomet water quality monitoring stations are as follows: **Site 1:** Middle of Pond, halfway between foot and head, **Site 2:** Foot of Pond, **Site 3:** Head of Pond. These locations are designated on **Map #1.**

Miacomet Pond Monitoring Results:

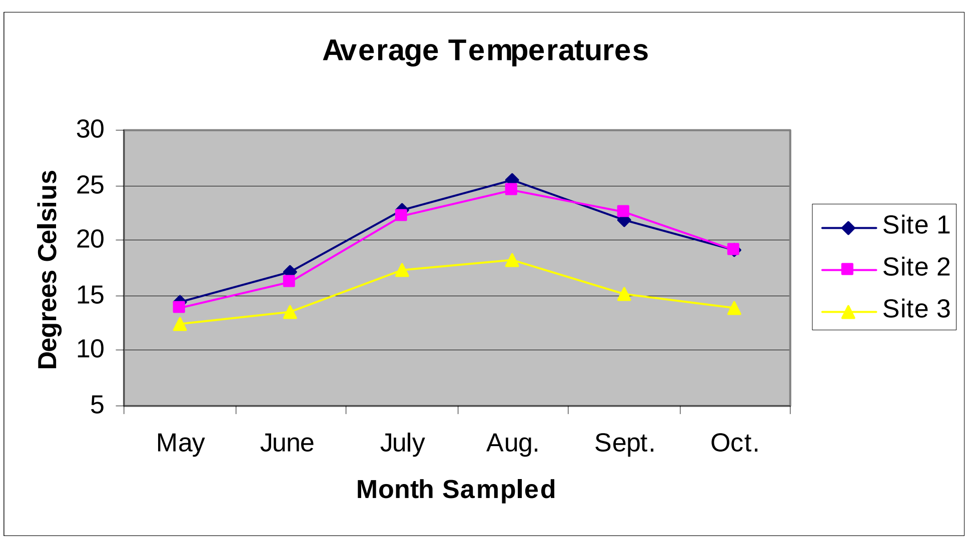
**Appendix A:** contains all physical and chemical water quality data. **Appendix B:** contains the averages of A with corresponding charts. **Appendix C:** contains average monthly rainfall for 2005, as collected by the Nantucket Water Company.

Average Temperatures:

Average temperatures in Miacomet rose steadily at all stations, from May through August. The month of September began to show a declining trend, as expected. The pond being a shallow water body is relatively well mixed, and would normally be isothermic. Site 1 at the middle, shows little stratification. However there are temperature differences between top and bottom at Site 2. This is the result of the exchanges with the ocean, and the salinity gradient that was established. At the foot (Site 2), the bottom saline waters in June were as much as 5º C cooler than the fresher surface waters (Appendix A).

At the opposite end of the pond, Site 3, fresh water inputs create an entirely different scenario. On average, temperatures at the head of the pond are close to 5º C cooler, than at the other two stations (Figure 1). In August, the average difference between Site 1, and Site 3, is 7.2º C. The bottom temperature difference at these two stations is 9.3º C, indicating a large groundwater influence at Site 3. Site 3 also has it's own thermocline, which is greater than 4º C (Appendix A). This situation is the result of large inputs from the ground water table, varying depth at the different locations, and the newly induced salinity gradients.

Figure 1: Average Temperatures



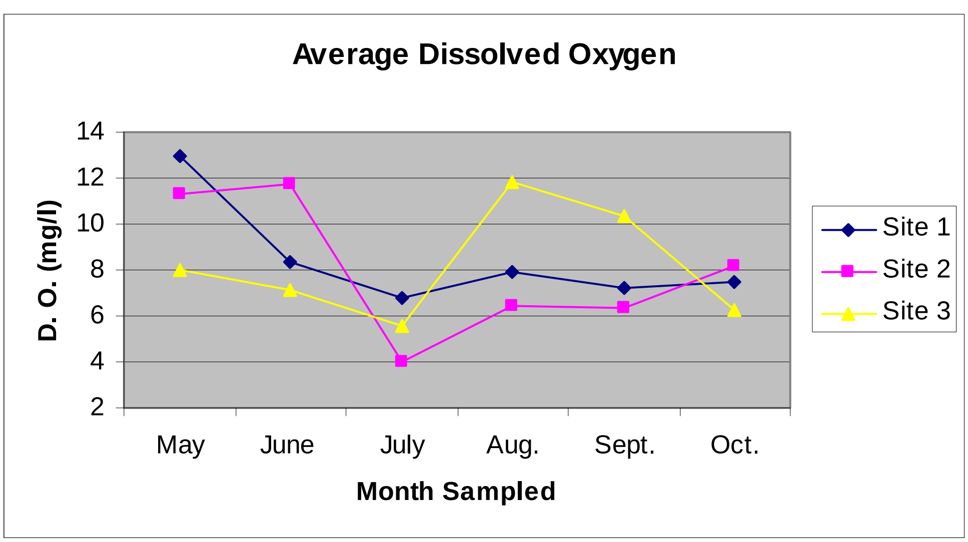
Dissolved Oxygen:

Dissolved oxygen is usually associated with temperature, in that the solubility of oxygen in water is directly proportional to variations in temperature. However, because of salinity changes, nutrient inputs, and the biological oxygen demand of anaerobic processes, the D. O. in Miacomet fluctuates wildly. These fluctuations, and low D.O. levels indicate that Miacomet is in a hyper-eutrophic state.

Many marine and fresh water organisms can become stressed when D. O. levels fall below 4 mg/l. Anoxic conditions, which are more prevalent at night because of respiration, are being seen with more regularity when sampling during the day. These anoxic conditions are predominantly occurring on the bottom, and most fish can escape these episodic events. However, there is a benthic community that is vital to the ecology of the pond that will suffer high mortality when these conditions persist. Excessive pond weed, the result of high nutrient inputs, often results in higher than normal D. O. levels during the photic period. However, these D. O. levels drop to lower than normal levels at night because of respiration, and get even worse when layers of decaying organic matter result in the complete consumption of oxygen by bacteria. A release of gasses from this anoxic mud was witnessed one calm morning (9/7) at Site 1, when the anchor was deployed and a 50 ft. radius of bubbles erupted around the boat.

Anoxic recordings were taken at bottom depths at Site 2 during July and August, and at site 3 during October (Appendix A). The average D. O. dropped noticeably at all stations during July (Figure 2), and was probably the result of ground water turning the pond back over to a predominantly fresh water system. This would cause the salt water phytoplankton species to die, which would then result in high levels of D.O. being consumed by bacteria. After this process was complete, and a fresh water system was re-established, average D. O. began to rise again at Sites 1, 2, and 3 (Figure 2). There was however a drop again in D.O. at Site 3, as eutrophic conditions dominated this area of low circulation. The biological oxygen demand was also probably high here, where intermittent draining had occurred, undoubtedly increasing the amount of decaying sub-aquatic vegetation.

Figure 2: Average Dissolved Oxygen



Salinity:

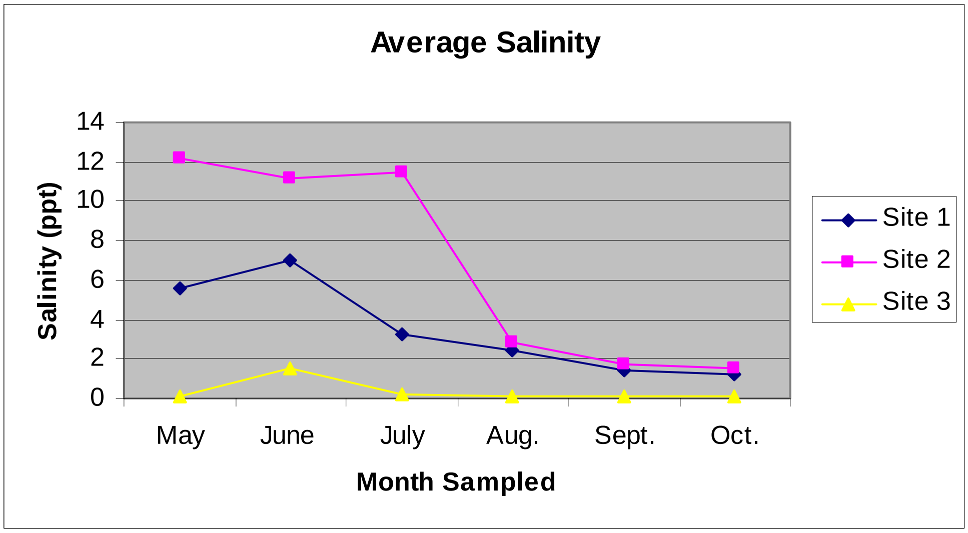
Salinity in Miacomet Pond was greatly affected by the openings that occurred from April to June. It was first opened 4/17 to alleviate flooding upon the request of many homeowners in and around the watershed. It closed 4/25, draining thoroughly, and turning the upper half into a mud flat. However due to the size ratio, 20:1, watershed to pond surface acreage, it filled rapidly. Because the barrier beach had been comprised by mechanical digging before (2003), it was even less stable now. A geo-morphological feature of this pond that slows the process of dune accretion is its location. Unlike Hummock and Sesachacha Ponds, which have expansive lateral coastlines, Miacomet is located at a bend along Nantucket's shoreline. Here, it is preceded by the Miacomet Rip, which interrupts the long shore transport of sand, prolonging the natural process of closure from long shore currents. The natural processes of dune accretion that closes the other ponds, sometimes quite rapidly, has yet to completely fill in Miacomet's new channel to the sea.

As a consequence of the repeated openings, the barrier beach during the summer of '05 was only 20-30 yards wide after any particular closure, it remained that way for many months. The channel that formed was 4-6ft. deep, 200ft. long, and 50ft. wide. In this condition the pond is very susceptible to breaching, especially when heavy precipitation occurs. High winds from the north combined with a rapidly rising water table can create a fetch strong enough and high enough to naturally breach the compromised barrier. One man with a shovel could very easily have the same affect, and once open, the pond has a tendency to dump, turning the upper portion into a mud flat. The pond opened three more times, after the fourth opening it was mechanically closed. The dates are as follows: open 4/17, close 4/25: open 5/22, close 5/25: open 6/5, close 6/8: open 6/12, close 6/15.

These successive openings basically turned Miacomet into an estuary, with a well defined salt water wedge. Salinity peaked on the bottom near the foot (Site 2) of the pond in July, where it was measured at 23 ppt. At the same location at the same time, surface salinity was measured at 3.7 ppt. (Appendix A). Sites 1, and 3 heading away from the ocean were not nearly as high, but were better mixed, with no visible gradient at this time in July. By the time of the August sampling round the salinity had equalized and dropped off considerably throughout the pond, with the most saline area being only 3.5 ppt at the foot (Site 2) on the bottom. During the next two months the pond continued to turn fresh with lower salinity levels, that were well mixed at all stations. By October Sites 1, 2, and 3 measured 1.2 ppt., 1.5 ppt., and 0.1 ppt. respectively.

A biological assessment of the pond has not been done in recent years. However water quality data would suggest that much of the benthic community at the lower end of the pond near the ocean would have been destroyed from the severe changes in salinity. Most fresh water species, flora and fauna can not withstand such dramatic and prolonged changes. Many of the pelagic fish may have escaped into the upper reaches of the pond, where it remained mostly fresh. In fact fishing was reported to be good by some anglers; however this was more likely due to the minimized volume of the pond after the openings.  Also of note, when considering the changing biota of the pond were the presence of more than two dozen coi, which were seen schooling at the southern end on 4/19/05.  These fish were approximately 2ft. long, and are known to dominate their water bodies once established.  Aggressive territorially, they also have a voracious appetite. And though they may be beneficial in clearing pond weed, primarily feeding on the bottom, they stir up sediments and re-suspend nutrients into the water column.  Not sought after by anglers, and not having natural predators, their numbers will undoubtedly grow unchecked.

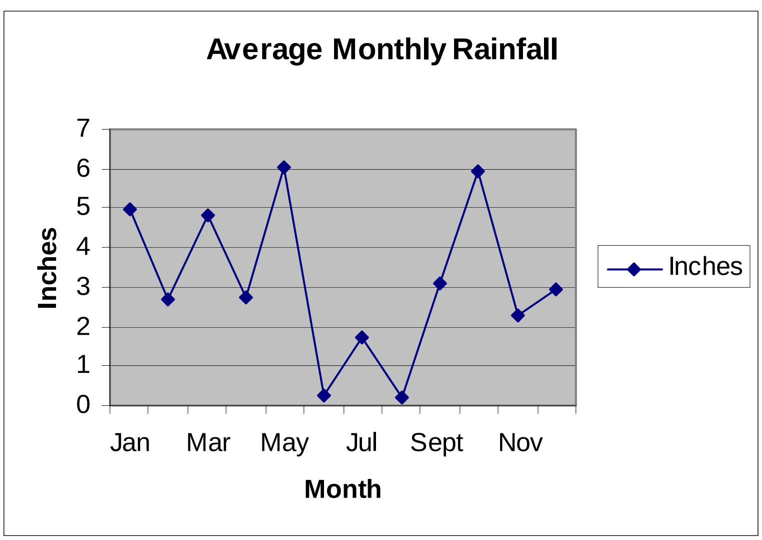
Figure 3: Average Salinity




Rainfall:

Average rainfall was collected by the Nantucket Water Company, and shows heavy precipitation in the spring.  In May alone, 6 inches of rain fell on the island's watersheds.  With a 20:1 watershed to pond size ratio, this amount of fresh water runoff would have contributed greatly to the re-occurring openings at the foot of the pond.

Figure 4: Average Monthly Rainfall

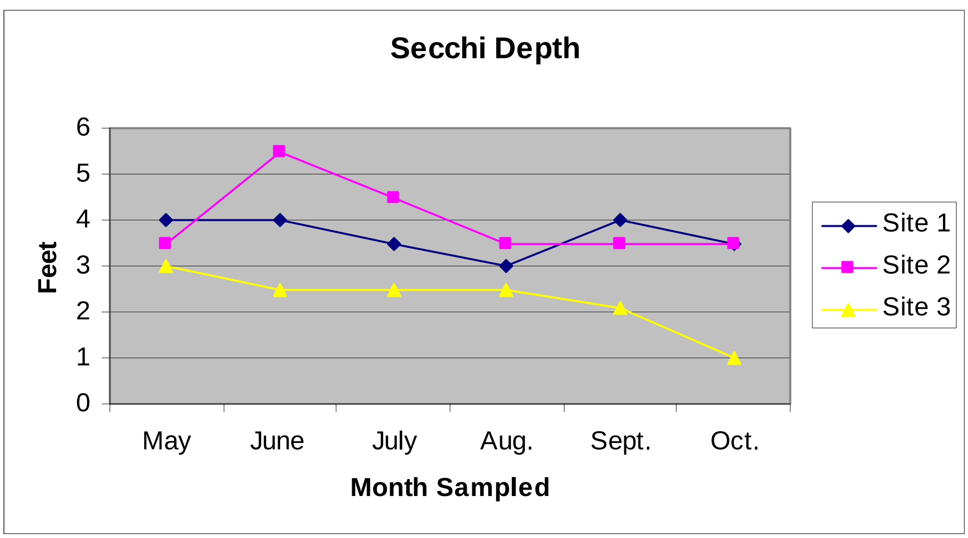


Secchi Depths:

Water transparency is often a good indicator of water quality. Secchi depths will indicate the amount of phytoplankton, algae, and nutrients available in the water column. The secchi disc can measure to depth, one half the amount of visible light penetrating through the water column. In Miacomet however, depths are often too shallow for secchi readings to give an accurate representation of water quality alone. However, when combined with all the other data, and analysis, the secchi recordings help to quantify the status of water quality.

Site 2 at the foot, has a depth below the 9ft. mark, and secchi here is not affected by emergent pond weeds. Readings here are more reliable, and indicative of water quality; as Sites 1, and 3 are so shallow they are affected by the abundant pond weed. Site 2 showed some fairly good transparency in June, but this was likely affected by the openings, and the salt water influx. At Site 1, clarity remained fairly constant, dropping off to a low of 3ft. in August (Figure 5). This was perhaps a result of increased temperatures, and the sudden drop in salinity resulting in a fresh water phytoplankton bloom. Site 3, experienced it's low for the sampling season in October, with the lowest reading for the pond at 1ft. This may be due to the gradual succession of the pond turning fresh again, combined with the high level of total nitrogen in the pond at the end of a prolonged summer; resulting in excessive pond weeds and phytoplankton.

Figure 5: Secchi Depth




Nutrients:

Nitrogen:

The limiting nutrient in a fresh water system is usually phosphorous, and for Miacomet this is often the case. However with all the openings, and exchanges with salt water, the pond has flipped it's nutrient limiting state many times. This has occurred in the past with this and other ponds on the island. Regardless of this change in salinity, and its effect, total nitrogen is very high in Miacomet. A eutrophic state would occur in a pond where total nitrogen was between 600-1,000 ppb. There were only three samples out of thirteen that were below this mark (Appendix A). Four samples were recorded above or near to 1,000 ppb indicating a hyper-eutrophic state.

Nitrate NO3, an inorganic state of nitrogen, and organic nitrogen, or Kjeldahl nitrogen TKN were both very high when sampling began in May. Inorganic nitrogen is readily accessible to plants, at levels above 150 ppb it will contribute to a eutrophic condition. In May these levels were 250 ppb at Site 1, and 260 ppb at Site 2 (Figure 6). This is also the time when the pond was turning into a marine system. The sampling rounds that followed showed nitrate dropping off dramatically, perhaps being rapidly taken up and utilized by the now marine dominated system.

Organic nitrogen, the major contributor to total nitrogen remained high throughout the summer. NO3 fell below the reportable limit by August, and remained so for the duration of the sampling period. This drop in NO3, lead to an initial drop in total nitrogen, when the system became a brackish or salt water pond. TKN takes longer to break down, and so is detectable longer, these values never fell below the eutrophic range. Total nitrogen began to rise again in August after the pond turned back into a fresh water system. This may be due, perhaps to the marine algae being no longer present, and no longer utilizing the nitrogen. This would allow for an increase in TN, because of the decline in its usage. In any case, organic nitrogen, from dissolved inorganic matter, and organic particulate matter is not as easily taken up in a marine system as the inorganic nitrogen, and hence remains present and identifiable in an aquatic system much longer. The main sources of nitrogen coming to the pond via the watershed are, according to Ivan Valiela, are the Miacomet Golf Course, septic systems, and fertilizers.

Figure 6: Inorganic Nitrogen

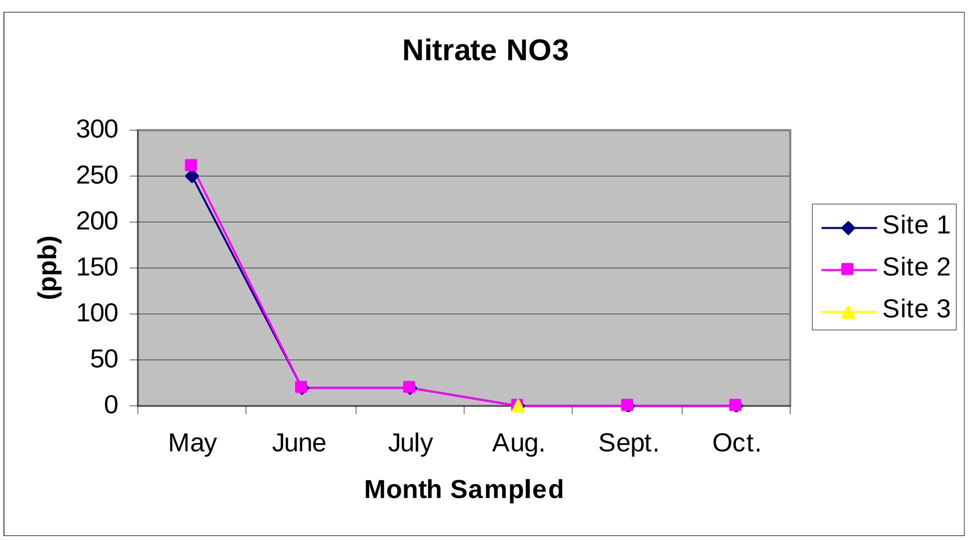
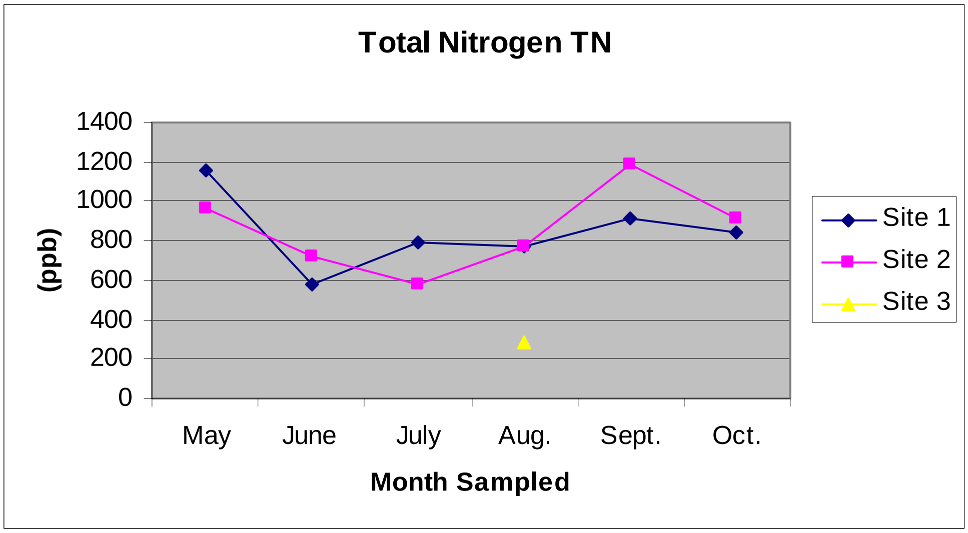


Figure 7: Total Nitrogen



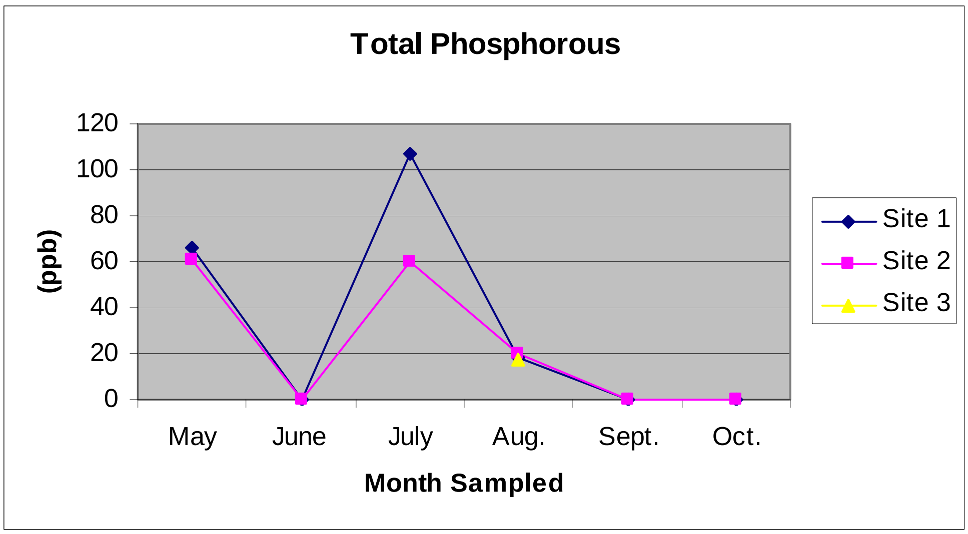

Phosphorous:

Total phosphorous is predominantly the limiting nutrient for plant growth in a fresh water system. This is usually the case in Miacomet, however as previously discussed when this pond is transformed into a marine system, nitrogen becomes the limiting nutrient. Total phosphorous levels at or between 15-25 ppb, would be indicative of a mesotrophic system with good to fair water quality. Initially the readings at Sites 1, and 2 were both around 60 ppb (Figure 8), already high enough to indicate a hyper-eutrophic state. These values dropped below the reportable limit in June, but jumped even higher in July than initially detected. This shows a correlation between the flip flopping of the system from fresh to marine, and back again; and the abundance or absence favored nutrients.

By the third round of sampling in July when the system was predominantly marine, TP values peaked at Site 1 to 107 ppb. The TP value at Site 2 was also back to its starting point when sampling began. This was also the time when nitrogen values were at their lowest. Perhaps this is because TP was not being as rapidly used up in the now marine aquatic system as TN. This can be further explored as a possibility, for by the fourth round of sampling TP was rapidly declining, and TN was rising; as the system became once again fresh. TP continued to drop off below the reportable limit for the last two sampling rounds, as the fresh water influence from the watershed re-established its dominance.

Phosphorous and nitrogen samples were only taken once at Site 3 during the summer of 2005. We wanted to get an initial reading prior to extensive sampling, as little was known about the water chemistry from this area. It is also not clear how this section of the pond influences, or is influenced by the rest of the water body. The sample taken in August, after the pond had been drained many times, and had also turned back to a fresh water system, showed relatively low values for TP, and TN. Perhaps this area was building itself back up again, utilizing all available nutrients. Because of the influence that the watershed has on the pond in this area, constantly adding fresh groundwater, it may be theorized that this sample taken at Site 3 indicates a constant load. To further strengthen this hypothesis, at this location, when the pond is at low levels, water can be seen flowing from the bank's sedimentary layers. If this is the case, then the abundance of nutrients in the main portion of the pond are being derived from the other sub-watersheds, and internal recycling. The added influence from the watershed at the head of the pond, at any level, will only exacerbate the existing eutrophic condition. To further explore this as a possibility water samples will be taken at the head pond (Site 3) in 2006, throughout the sampling period.

Figure 8: Total Phosphorous




Conclusions:

In order for the health of Miacomet Pond to improve, some forms of remediation must be implemented. Because the watershed is so large compared to its associated water body, the pond will always be a predominantly a fresh water system. Attempts to control flooding by opening the pond only increase and accelerate the trend toward eutrophication. When the pond is drained, nutrients are drawn down into the pond from the outlying watershed. Because of the soil type, this happens at a near instantaneous rate. Attempts to alleviate flooding would be less harmful to the pond's ecosystem if some sort of pumping system were employed. This way there would be no exchange with the ocean, and a flip flopping of limiting nutrients would not occur. Alternative methods of filtration should be employed with respects to nutrients from the golf course, and septic systems. Some sort of filtration should be considered for the runoff from the road that is sloped in the direction of the pond. Dredging may be necessary to remove existing nutrients in the sediments, and excessive nuisance pond weeds. Lastly, to restore the pond to a natural healthy fresh water system, the coi must be removed. For this an electric shocking method, which stuns the fish momentarily may be used. This may be detrimental to other fish, but allowing the coi to proliferate could be much worse. There are no easy quick fixes with regards to the health of this pond, however these, and or other solutions should be investigated.

Apendix A

Miacomet Pond 2005

Site 1 Middle of Pond
Site 2 Foot of Pond
Site 3 Head of Pond

Temperature ºC

| Site 1 | 5/4/2005 | 6/2/2005 | 7/6/2005 | 8/3/2005 | 9/7/2005 | 10/4/2005 |
|---|---|---|---|---|---|---|
| 0 | 14.2 | 16.9 | 22.7 | 25.7 | 21.9 | 19.3 |
| 3 | 14.5 | 17.1 | 22.8 | 25.5 | 21.8 | 19.1 |
| 5 | 14.7 | 17.2 | 22.8 | 25.4 | 21.7 | 19.1 |

| Site 2 | 5/4/2005 | 6/2/2005 | 7/6/2005 | 8/3/2005 | 9/7/2005 | 10/4/2005 |
|---|---|---|---|---|---|---|
| 0 | 13.5 | 17.5 | 22.7 | 25.1 | 22.8 | 19.2 |
| 3 | 13.2 | 18.1 | 22.7 | 25 | 22.8 | 19.2 |
| 6 | 13.9 | 17.1 | 23.1 | 24.8 | 22.6 | 19.1 |
| 9 | 14.4 | 12.3 | 21.9 | 23.6 | 22.5 | 19.1 |
| 9.5 | 14.1 | | 20.5 | | 22.4 | 19.1 |

| Site 3 | 5/4/2005 | 6/2/2005 | 7/6/2005 | 8/3/2005 | 9/7/2005 | 10/4/2005 |
|---|---|---|---|---|---|---|
| 0 | 12.7 | 13.2 | 16.7 | 20.4 | 15.4 | 14.6 |
| 3 | 12.1 | 13.9 | 17.9 | 16.1 | 14.7 | 13.1 |

Dissolved Oxygen mg/l

| Site 1 | 5/4/2005 | 6/2/2005 | 7/6/2005 | 8/3/2005 | 9/7/2005 | 10/4/2005 |
|---|---|---|---|---|---|---|
| 0 | 10.05 | 8.51 | 6.95 | 8.14 | 7.18 | 8.45 |
| 3 | 13.01 | 8.35 | 6.74 | 7.8 | 7.29 | 8.25 |
| 5 | 15.86 | 8.24 | 6.66 | 7.72 | 7.18 | 5.66 |

| Site 2 | 5/4/2005 | 6/2/2005 | 7/6/2005 | 8/3/2005 | 9/7/2005 | 10/4/2005 |
|---|---|---|---|---|---|---|
| 0 | 10.62 | 9.21 | 6.43 | 8.02 | 6.84 | 8.32 |
| 3 | 10.92 | 9.33 | 6.41 | 7.97 | 7.01 | 8.22 |
| 6 | 14.22 | 15.54 | 7.04 | 7.95 | 6.92 | 8.16 |
| 9 | 10.61 | 13.01 | 0.07 | 1.78 | 6.62 | 8.11 |
| 9.5 | 9.96 | | 0.04 | | 4.43 | 7.96 |

| Site 3 | 5/4/2005 | 6/2/2005 | 7/6/2005 | 8/3/2005 | 9/7/2005 | 10/4/2005 |
|---|---|---|---|---|---|---|
| 0 | 7.97 | 6.21 | 4.75 | 10.09 | 10.21 | 11.41 |
| 3 | 8.09 | 8.09 | 6.4 | 13.49 | 10.45 | 1.13 |

Salinity ppt.

| Site 1 | 5/4/2005 | 6/2/2005 | 7/6/2005 | 8/3/2005 | 9/7/2005 | 10/4/2005 |
|---|---|---|---|---|---|---|
| 0 | 2.8 | 6.9 | 3.2 | 2.3 | 1.4 | 1.2 |
| 3 | 6.3 | 7 | 3.3 | 2.4 | 1.5 | 1.2 |
| 5 | 7.5 | 7 | 3.2 | 2.4 | 1.4 | 1.2 |

| Site 2 | 5/4/2005 | 6/2/2005 | 7/6/2005 | 8/3/2005 | 9/7/2005 | 10/4/2005 |
|---|---|---|---|---|---|---|
| 0 | 3.2 | 8 | 3.7 | 2.5 | 1.7 | 1.5 |
| 3 | 5.6 | 8.5 | 3.7 | 2.5 | 1.7 | 1.5 |
| 6 | 9 | 11.7 | 4.4 | 2.6 | 1.7 | 1.5 |
| 9 | 21.7 | 16.7 | 22.8 | 3.5 | 1.8 | 1.5 |
| 9.5 | 21.7 | | 23 | | 1.8 | 1.5 |

| Site 3 | 5/4/2005 | 6/2/2005 | 7/6/2005 | 8/3/2005 | 9/7/2005 | 10/4/2005 |
|---|---|---|---|---|---|---|
| 0 | 0.1 | 1.1 | 0.2 | 0.1 | 0.1 | 0.1 |
| 3 | 0.1 | 1.8 | 0.2 | 0.1 | 0.1 | 0.1 |

Secchi ft.

| | 5/4/2005 | 6/2/2005 | 7/6/2005 | 8/3/2005 | 9/7/2005 | 10/4/2005 |
|---|---|---|---|---|---|---|
| Site 1 | 4 | 4 | 3.5 | 3 | 4 | 3.5 |
| Site 2 | 3.5 | 5.5 | 4.5 | 3.5 | 3.5 | 3.5 |
| Site 3 | 3 | 2.5 | 2.5 | 2.5 | 2.1 | 1 |

Nitrate NO3 ppb

| | 5/4/2005 | 6/2/2005 | 7/6/2005 | 8/3/2005 | 9/7/2005 | 10/4/2005 |
|---|---|---|---|---|---|---|
| Site 1 | 250 | 20 | 20 | BRL | BRL | BRL |
| Site 2 | 260 | 20 | 20 | BRL | BRL | BRL |
| Site 3 | | | | BRL | | |

Organic Nitrogen TKN ppb

| | 5/4/2005 | 6/2/2005 | 7/6/2005 | 8/3/2005 | 9/7/2005 | 10/4/2005 |
|---|---|---|---|---|---|---|
| Site 1 | 910 | 560 | 770 | 770 | 910 | 840 |
| Site 2 | 700 | 700 | 560 | 770 | 1,190 | 910 |
| Site 3 | | | | 280 | | |

Total Nitrogen TN ppb

| | 5/4/2005 | 6/2/2005 | 7/6/2005 | 8/3/2005 | 9/7/2005 | 10/4/2005 |
|---|---|---|---|---|---|---|
| Site 1 | 1160 | 580 | 790 | 770 | 910 | 840 |
| Site 2 | 960 | 720 | 580 | 770 | 1,190 | 910 |
| Site 3 | | | | 280 | | |

Amonia NH3 ppb

| | 5/4/2005 | 6/2/2005 | 7/6/2005 | 8/3/2005 | 9/7/2005 | 10/4/2005 |
|---|---|---|---|---|---|---|
| Site 1 | BRL | BRL | BRL | BRL | BRL | BRL |
| Site 2 | BRL | BRL | BRL | BRL | BRL | BRL |
| Site 3 | | | | BRL | | |

Total Phosphorus TP ppb

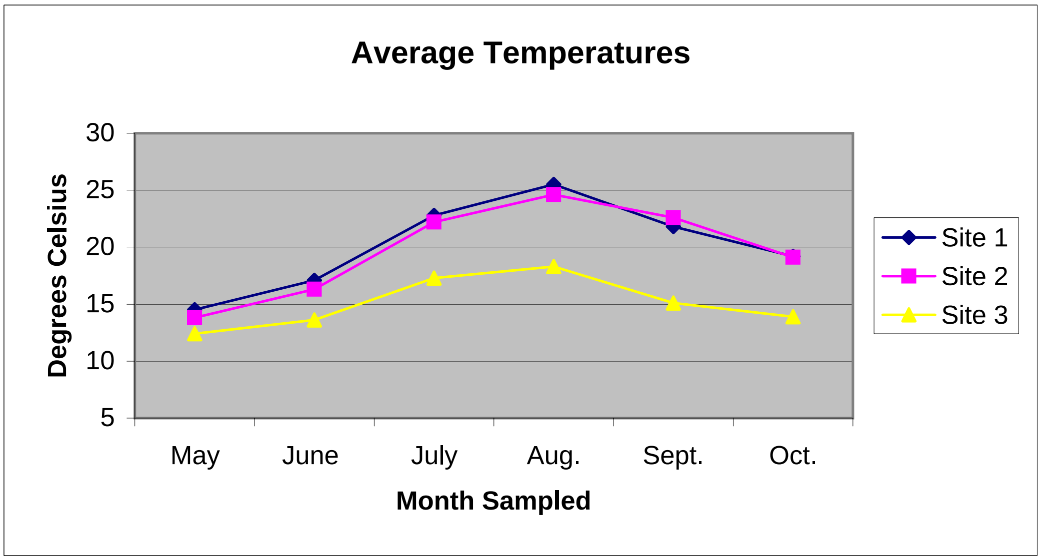
| | 5/4/2005 | 6/2/2005 | 7/6/2005 | 8/3/2005 | 9/7/2005 | 10/4/2005 |
|---|---|---|---|---|---|---|
| Site 1 | 66 | BRL | 107 | 18 | BRL | BRL |
| Site 2 | 61 | BRL | 60 | 20 | BRL | BRL |
| Site 3 | | | | 17 | | |

Appendix B

Miacomet Average Physical and Chemical Parameters 2005

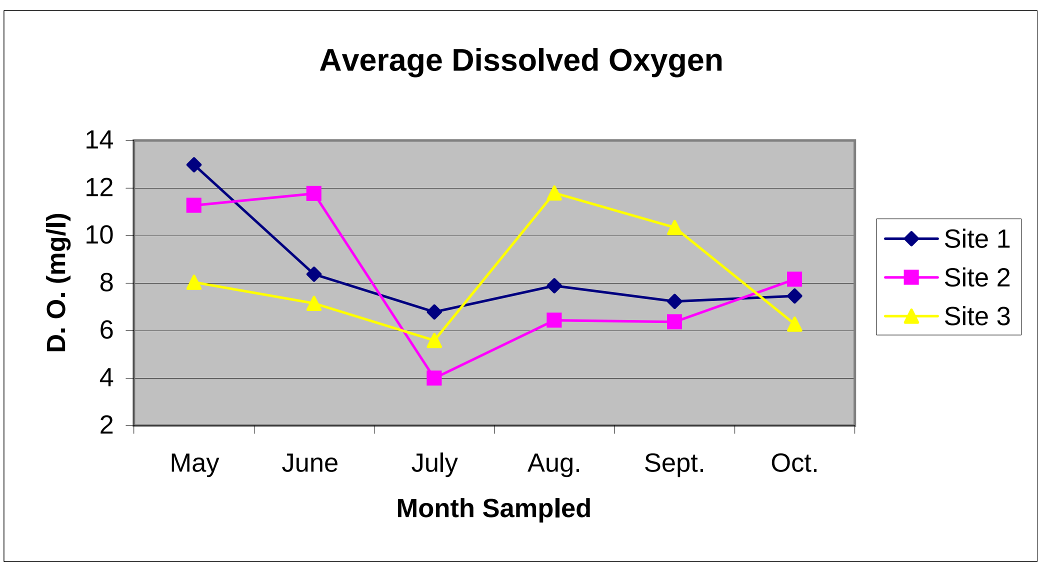
Average Tempearatures (ºC)

| | May | June | July | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|
| Site 1 | 14.5 | 17.1 | 22.8 | 25.5 | 21.8 | 19.2 |
| Site 2 | 13.8 | 16.3 | 22.2 | 24.6 | 22.6 | 19.1 |
| Site 3 | 12.4 | 13.6 | 17.3 | 18.3 | 15.1 | 13.9 |



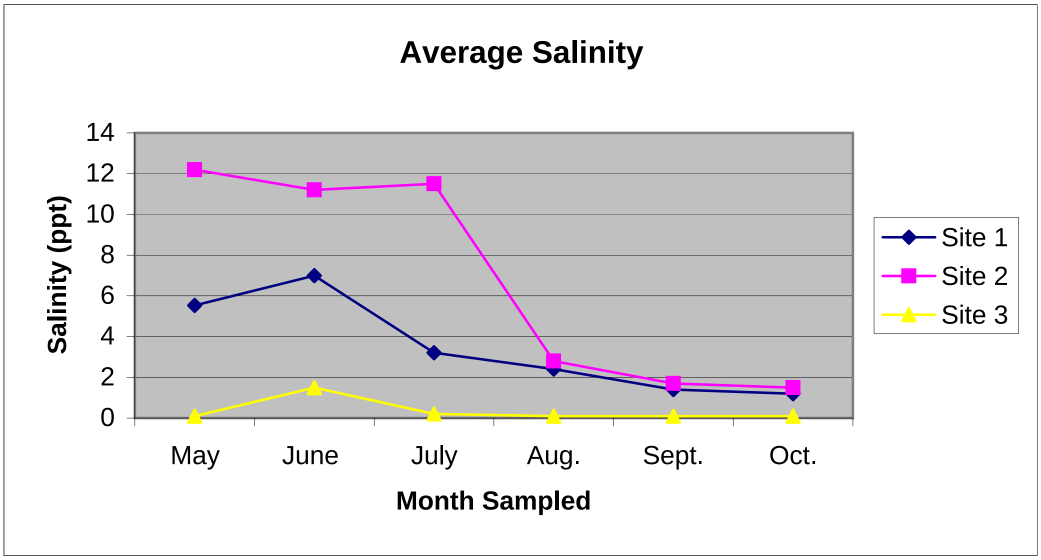

Average Dissolved Oxygen (mg/l)

| | May | June | July | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|
| Site 1 | 12.97 | 8.37 | 6.78 | 7.89 | 7.22 | 7.45 |
| Site 2 | 11.27 | 11.77 | 3.99 | 6.43 | 6.36 | 8.15 |
| Site 3 | 8.03 | 7.15 | 5.58 | 11.79 | 10.33 | 6.27 |



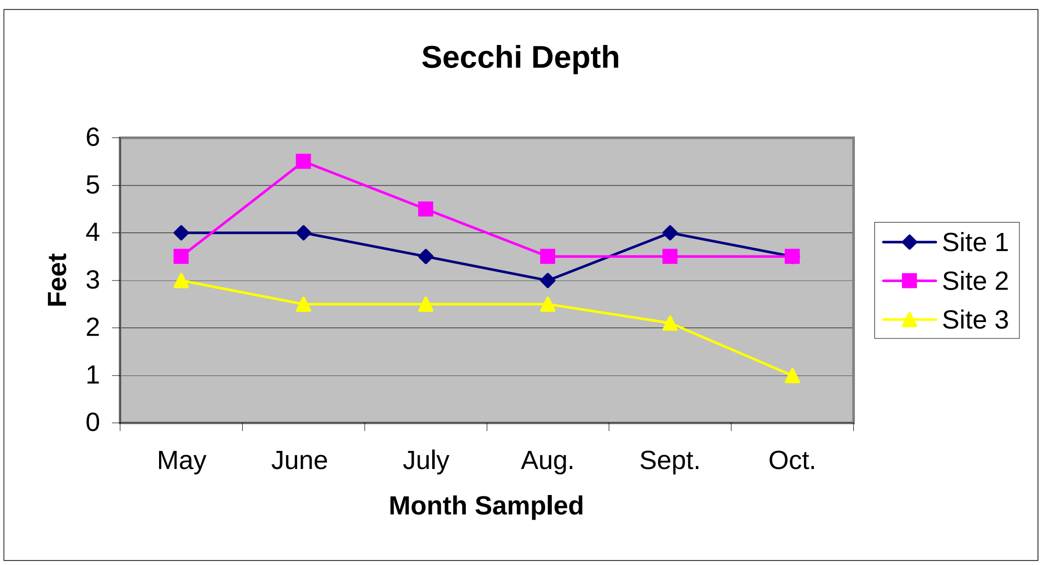
Average Salinity (ppt)

| | May | June | July | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|
| Site 1 | 5.53 | 7 | 3.2 | 2.4 | 1.4 | 1.2 |
| Site 2 | 12.2 | 11.2 | 11.5 | 2.8 | 1.7 | 1.5 |
| Site 3 | 0.1 | 1.5 | 0.2 | 0.1 | 0.1 | 0.1 |



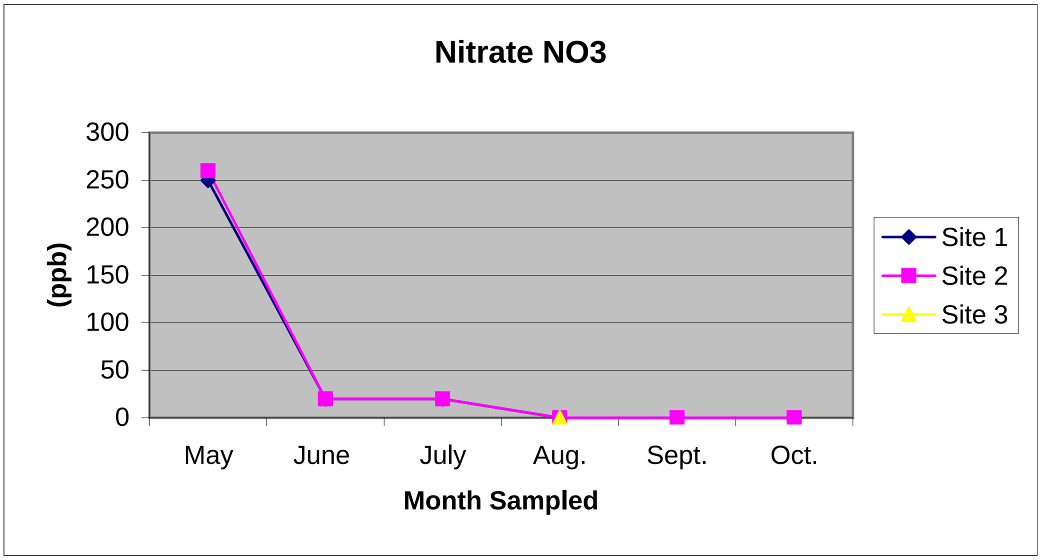

Secchi Depth (ft.)

| | May | June | July | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|
| Site 1 | 4 | 4 | 3.5 | 3 | 4 | 3.5 |
| Site 2 | 3.5 | 5.5 | 4.5 | 3.5 | 3.5 | 3.5 |
| Site 3 | 3 | 2.5 | 2.5 | 2.5 | 2.1 | 1 |



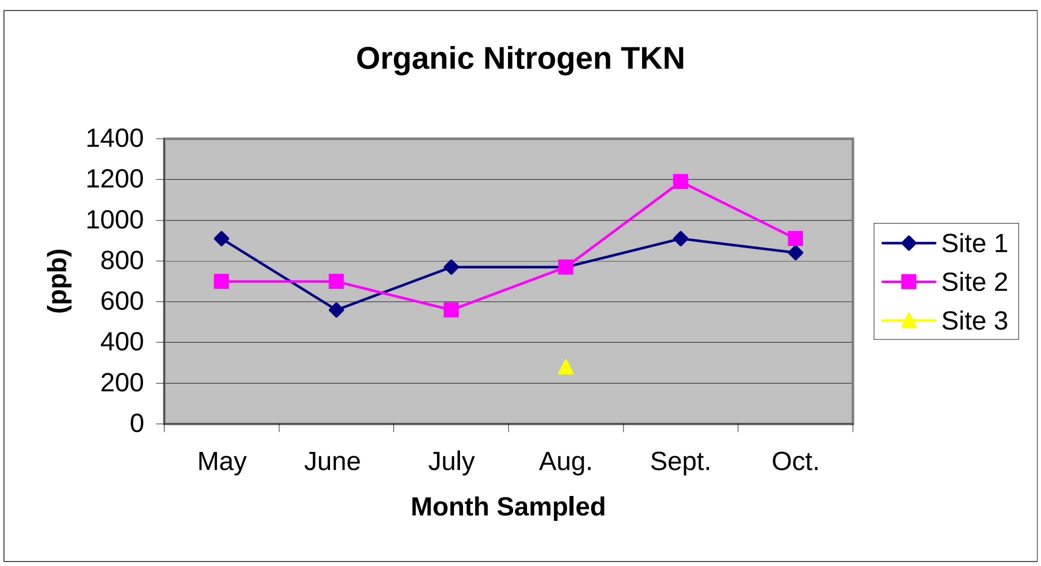
Nitrate NO3 (ppb)

| | May | June | July | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|
| Site 1 | 250 | 20 | 20 | BRL | BRL | BRL |
| Site 2 | 260 | 20 | 20 | BRL | BRL | BRL |
| Site 3 | | | | BRL | | |



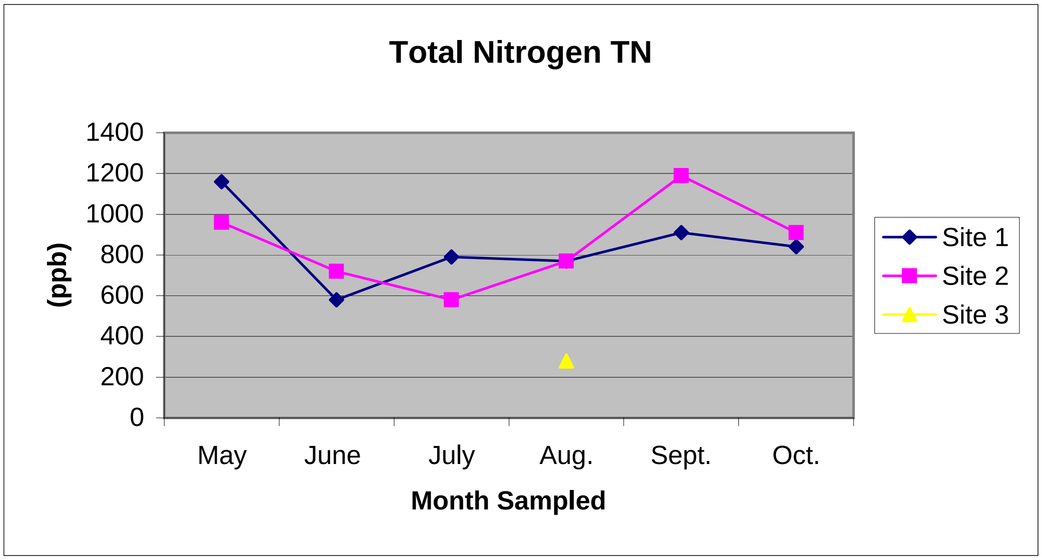

Organic Nitrogen TKN (ppb)

| | May | June | July | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|
| Site 1 | 910 | 560 | 770 | 770 | 910 | 840 |
| Site 2 | 700 | 700 | 560 | 770 | 1,190 | 910 |
| Site 3 | | | | 280 | | |



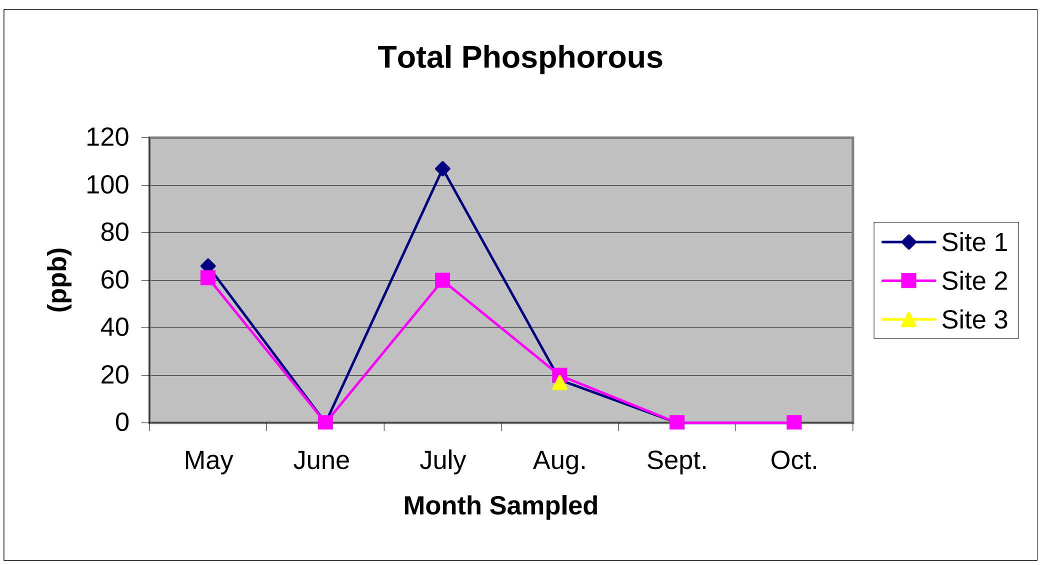
Total Nitrogen TN (ppb)

| | May | June | July | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|
| Site 1 | 1160 | 580 | 790 | 770 | 910 | 840 |
| Site 2 | 960 | 720 | 580 | 770 | 1,190 | 910 |
| Site 3 | | | | 280 | | |




Total Phosphorus TP (ppb)

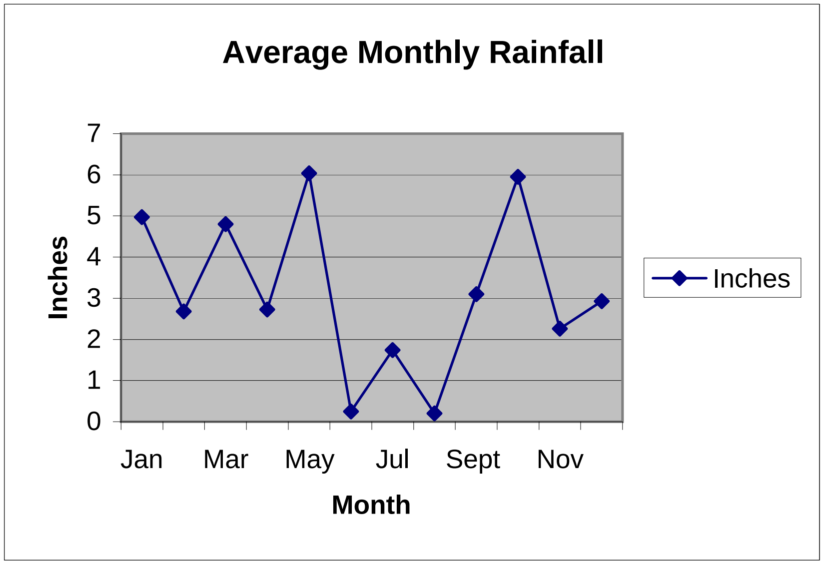
| | May | June | July | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|
| Site 1 | 66 | BRL | 107 | 18 | BRL | BRL |
| Site 2 | 61 | BRL | 60 | 20 | BRL | BRL |
| Site 3 | | | | 17 | | |



Appendix C

Average Monthly Rainfall 2005

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inches | 4.97 | 2.68 | 4.8 | 2.73 | 6.04 | 0.25 | 1.74 | 0.2 | 3.1 | 5.95 | 2.26 | 2.93 |




Total Rainfall: 37.65 "